

Analysis Phase

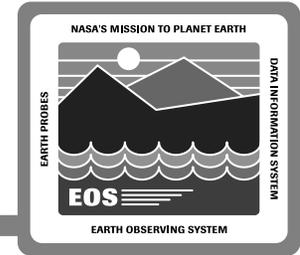
Marlene Quick-Campbell

Roger Sheldon

Shawn Firth

14 December 1994

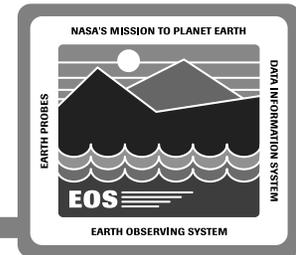
Analysis Phase



Analysis phase to be presented in 4 steps

- **Request generation**
 - GUI environment which allows the user to customize a request utilizing a suite of tools provided by the system
- **Setup**
 - Configuration and setup of the data processing environment
- **Data processing**
 - Actual processing of the data according to the user specifications
- **Output**
 - Presentation of the analysis results in the format requested by the user

Analysis Phase (cont.)



Request Generation

- Request
 - Time
 - Triggers
 - Standing Orders
- Request Builder
- Status Display

Setup

- Request Partitioning
- Telemetry Configuration
- Data Retrieval

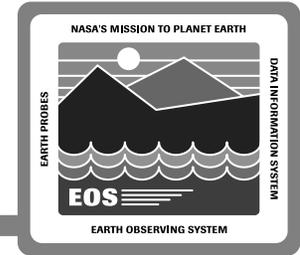
Data Processing

- Telemetry Decom
- Data Reduction
- Algorithms
- Datasets
- Report Preparation

Output

- Output Generation
- Graphs
- Tables
- Reports
- Carry Out
- Dataset Overlays

Analysis Phase (cont.)

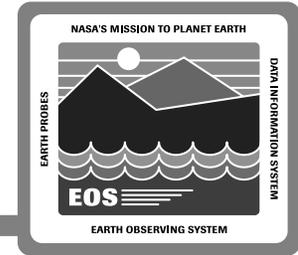


Analysis is an off-line tool available to the FOT/IOT for performing the following tasks:

- **Performance monitoring**
- **Trend analysis**
- **Anomaly resolution**
- **Spacecraft/Instrument resource management**
- **Fault detection, isolation, and recommendation**
- **Assisting in routine day-to-day operational tasks**

Analysis functions are provided on a non-interference basis with the real-time telemetry and command processing

Analysis Phase (cont.)



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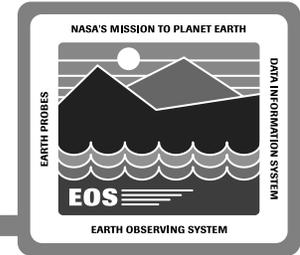
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Analysis Request

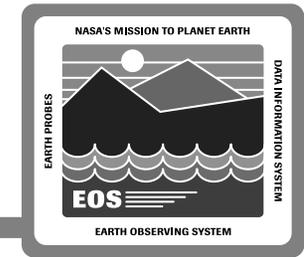


Method for specifying the processing of history data for spacecraft & instrument analysis

Request types:

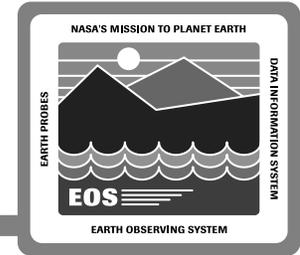
- **Absolute time based analysis request. Output formats include:**
 - **Graph**
 - **Table**
 - **Report**
 - **Carry out**
- **Event triggers**
 - **Analysis request or procedure executed upon a specified event**
- **Standing orders**
 - **Analysis request executed upon specified future times**

Prototype Analysis Request Builder Window



Available in hardcopy only.

Analysis Request Builder



Subsystem selector tool

- **Provides Spacecraft /Instrument filtering**
 - Access provided to all available spacecraft
 - Subsystems/instruments provided based upon S/C selections
 - Telemetry parameters provided based upon subsystem selection

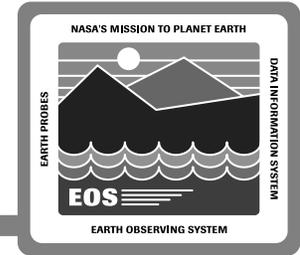
Time selector tool

- **Provides options for selecting start/stop dates and times**
 - Absolute times
 - Relative times (orbit, pass, equator crossing...)

Standing order interval selector

- **Provides options for selecting relative time intervals**
 - Select execution start/stop dates and times
 - Select frequency (e.g., 5:00p.m. every 5th day)

Analysis Request Builder (cont.)



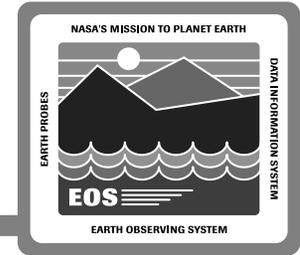
Data Reduction

- **Sampling Rate**
 - All data, changes only, every nth sample
- **Data Filters**
 - All data, min-max reduced (minute interval)

Algorithms

- **System supplied**
 - Min, max, mean, etc.
 - AM1 specific algorithms (e.g., Electrical Power Subsystem Analysis)
- **User supplied**
 - Method for FOT/IOT to input user defined algorithms
 - Algorithms defined using C language

Analysis Request Builder (cont.)



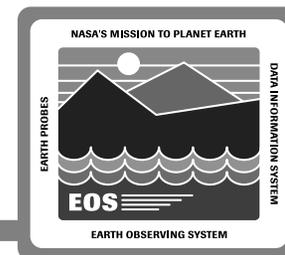
Output destination

- File or printer

Product View format options include:

- Choose telemetry parameters (from available list)
- Specify time format (time selections bounded by original request)
- Choose graph/table attributes
 - X,Y coordinates
 - Line style
 - Scaling
 - Colors/symbols
 - Unit specifiers
- Specify report formats
 - Report template builder

Analysis Status Display



Displays the status of the analysis requests:

- **Completed**
- **Processing (gathering data, processing data, generating output)**
- **Pending**

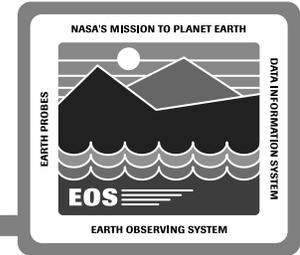
Provides capability to manage pending requests

- **Re-order priority, default is FIFO**
- **Delete requests**

Design benefits:

- **Provides snapshot view of multiple request status**
- **Allows quick access to product selections of completed requests**

Request Generation Scenario



User invokes Analysis Request Builder

User selects options

User selects “save”

Request is built and stored

User selects option to start processing

Request is sent to request handler

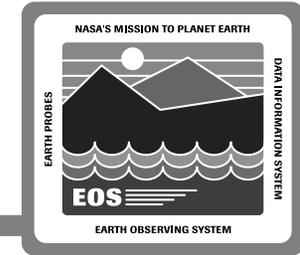
Request handler routes request for processing

Request handler receives and displays status

Data set is received upon processing completion

User invokes Analysis Product Selector to select output products

Request Generation Design Benefits



Request builder supplies one stop shopping for all your analysis needs

- **Accommodate every type of analysis request**
- **Minimize the amount of steps required to build request (defaults)**
- **Provide easy selections (use of tools, error-free requests)**
- **Reuse previous requests and formats**

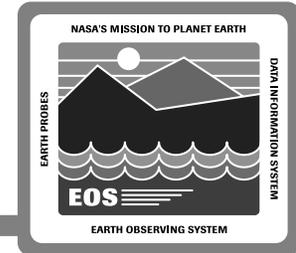
Standing Orders and Triggers

- **Provide flexible/extendable analysis system**
- **Automate mundane FOT/IOT tasks (periodic reports)**

Analysis Status Display provides FOT/IOT insight into processing

Allows for further products to be selected from original data gather (more about that in the Analysis Output discussion)

Analysis Phase



Request Generation

- Request
 - Time
 - Triggers
 - Standing Orders
- Request Builder
- Status Display

Setup

- **Request Partitioning**
- **Telemetry Configuration**
- **Data Retrieval**

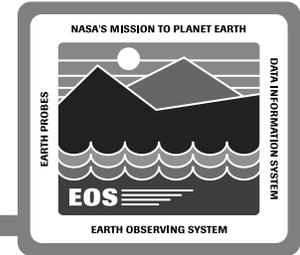
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Setup



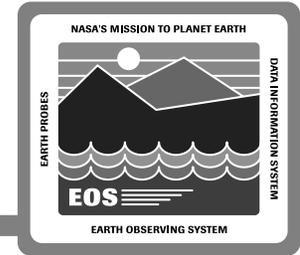
Setup of analysis establishes the environment for processing the data

- **Determines the appropriate data base/data bases to be used**
- **Partition the request into multiple requests if data base crossover encountered**
 - **Transparent to the user**
- **Start up and configure local copy of telemetry decommutation software**
- **Retrieve requested data from the local and/or long term archive**

Setup and data processing are required only for the processing of spacecraft and instrument data

Setup and data processing are not required for system-generated statistics, NCC data, or EDOS data (only data retrieval required)

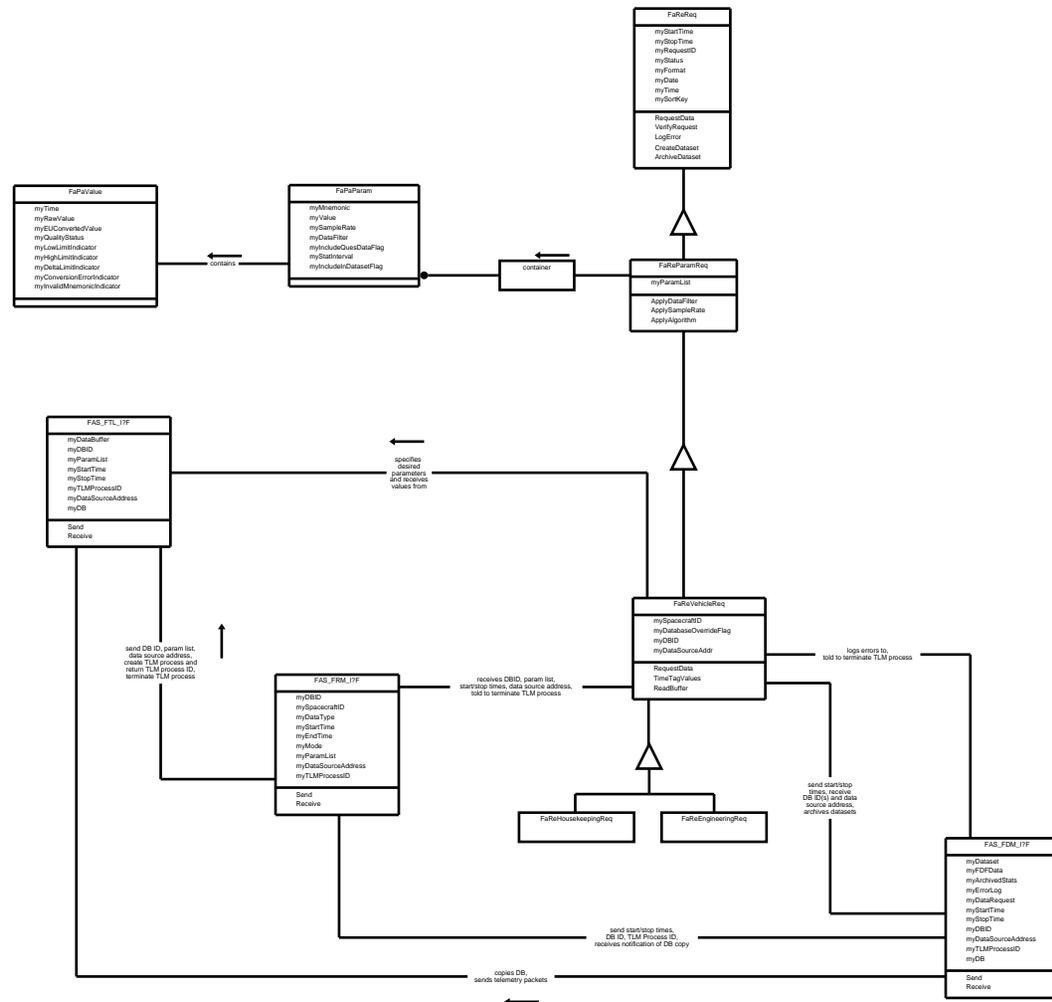
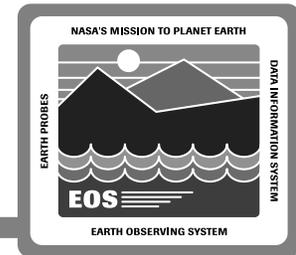
Request Partitioning



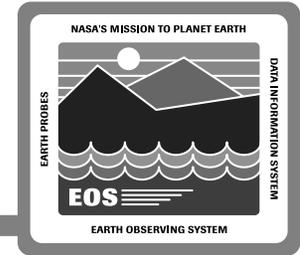
Process of associating the data requested with the appropriate data base(s) for processing

- **All data bases used operationally are maintained in the archive**
- **Data Management maintains a table cross referencing data base IDs with active periods**
- **Single request for analysis could span an interval in which more than one data base was used operationally**

Request Partitioning Object Model



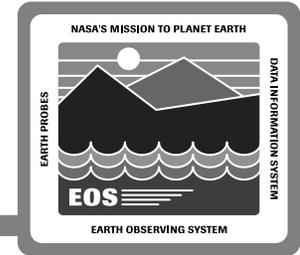
Request Partitioning (cont.)



Data Base information requested from Data Management

- **System supplies request interval start and stop times to Data Management**
- **Data Management returns a list of data base IDs and their active periods within the interval requested**
- **Original request is partitioned into multiple requests if required**
 - **User has the option to override this process by specifying data base ID during request generation**
 - **The process of partitioning the request into multiple requests is totally transparent to the user**
 - **Single output product, as requested, is returned to the user**

Request Partitioning Benefits



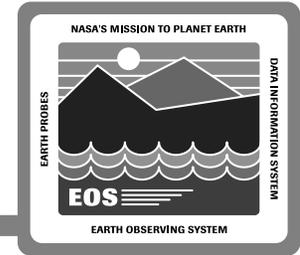
Allows users to request data analysis without regard to data base identification, particularly during cross over periods

- **Done automatically by the system**

Data, by default, is processed according to the data base which was active during the interval requested

Provides flexibility to allow user to specify data base to use for specialized processing needs

Telemetry Configuration



User requests telemetry for analysis

- **Decom parameter list**
- **Start and stop times**

Database requested from Data Management

- **Start and stop times**

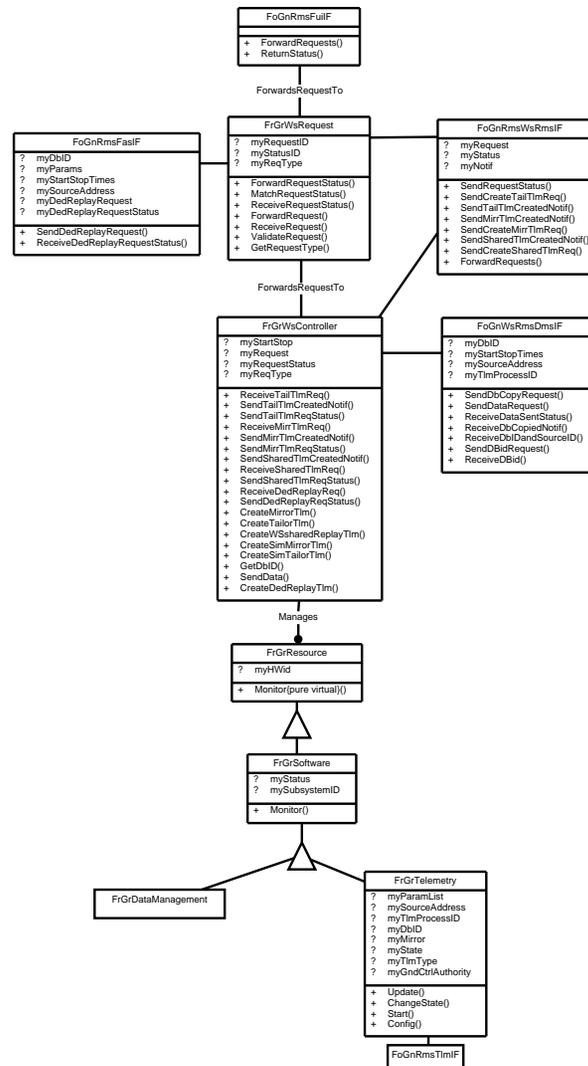
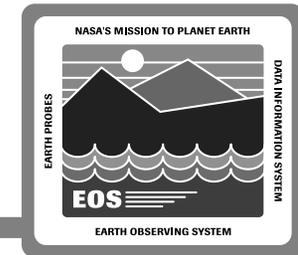
Telemetry Software Configured for Decom

- **Database ID from Data Management**
- **Decom parameter list from user**
- **Data source address from Data Management**

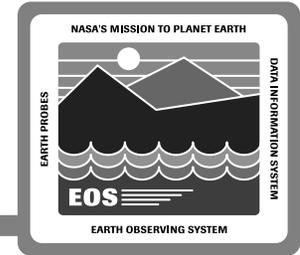
Data Management notified that TLM ready to receive data

- **Destination address for Telemetry Software**

Telemetry Configuration Object Diagram



Data Retrieval



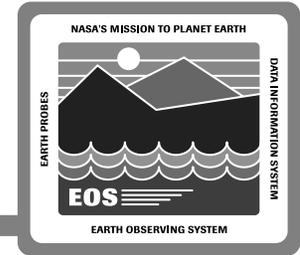
Request Queue Manager

- Requests for archived telemetry data from the EOC Workstations and IST's are queued at the Data Server
- Predetermined number of requests are processed simultaneously
 - An evaluation will be performed prior to CDR to determine the number of requests which can be processed simultaneously

Telemetry Location

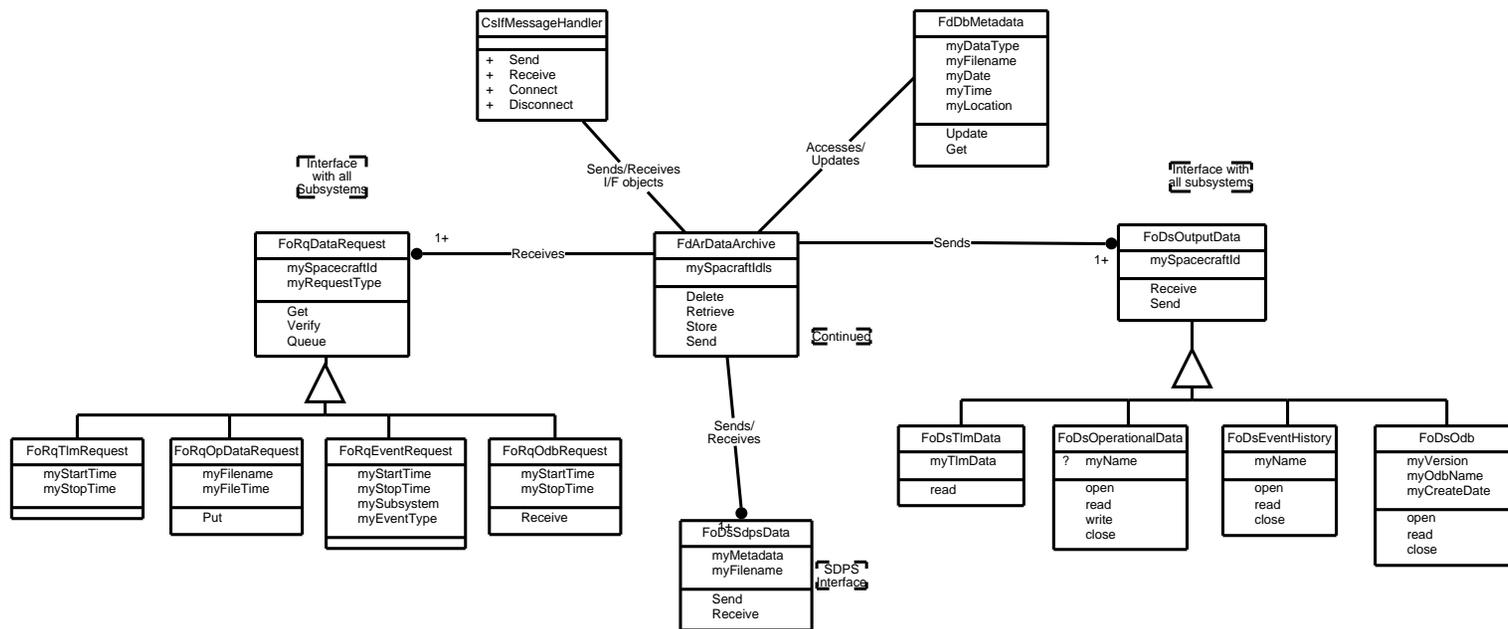
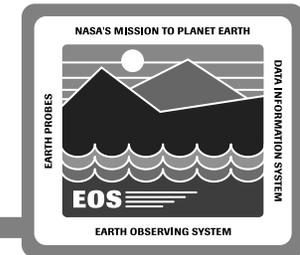
- Determine where requested telemetry data is located by accessing metadata in the data base
 - uses start time and stop time in request
- Metadata helps determine filename, file size, and file location of telemetry files needed to support request

Data Retrieval (cont.)

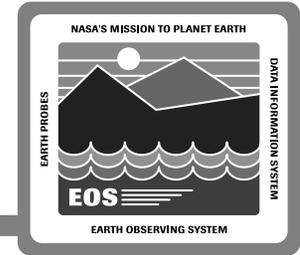


- **SDPS Interface**
 - **Only required if data not available at the EOC**
Transparent to the user
 - **FOS Data Server sends a telemetry file location request to the SDPS Advertisement Server**
 - **SDPS Advertisement Server at the DAAC responds with SDPS Data Server address**
 - **FOS Data Server requests the telemetry files from the SDPS Data Server**
 - **SDPS Data Server at the DAAC will send the telemetry files to a staging area in the FOS**
 - **Staging area is maintained by the FOS Data Server**

Telemetry Retrieval Object Model



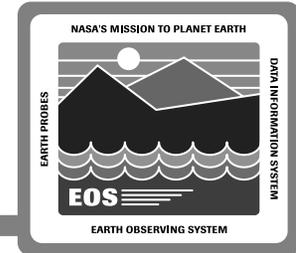
Data Retrieval (cont.)



Telemetry Distribution

- **Telemetry packets are sent point to point to a Decom Process on the requesting workstation**
 - **Currently evaluating sending telemetry files to the requesting workstation, and then feeding telemetry packets to the Decom Process**
- **End-of-data indicator is provided when all requested data has been retrieved from the archive**

Analysis Phase (cont.)



Request Generation

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Setup

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- Telemetry Configuration
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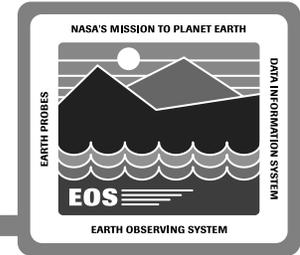
Data Processing

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Data Processing



The telemetry process receives packets from data management

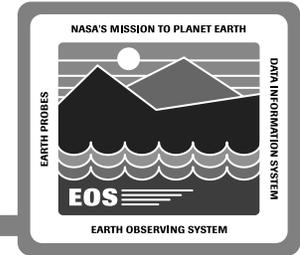
The packets are decommed

Optionally, the number of telemetry points may be reduced by applying sample rates and/or data filters

Optionally, an algorithm may be applied to the telemetry to compute further information

The final results are written to a dataset or a routine report

Telemetry Decom



Receive historical telemetry EDUs

Extract telemetry information

- **CCSDS telemetry packet**

Decommutate telemetry

- **Extract commutated parameters**

Calculate derived telemetry

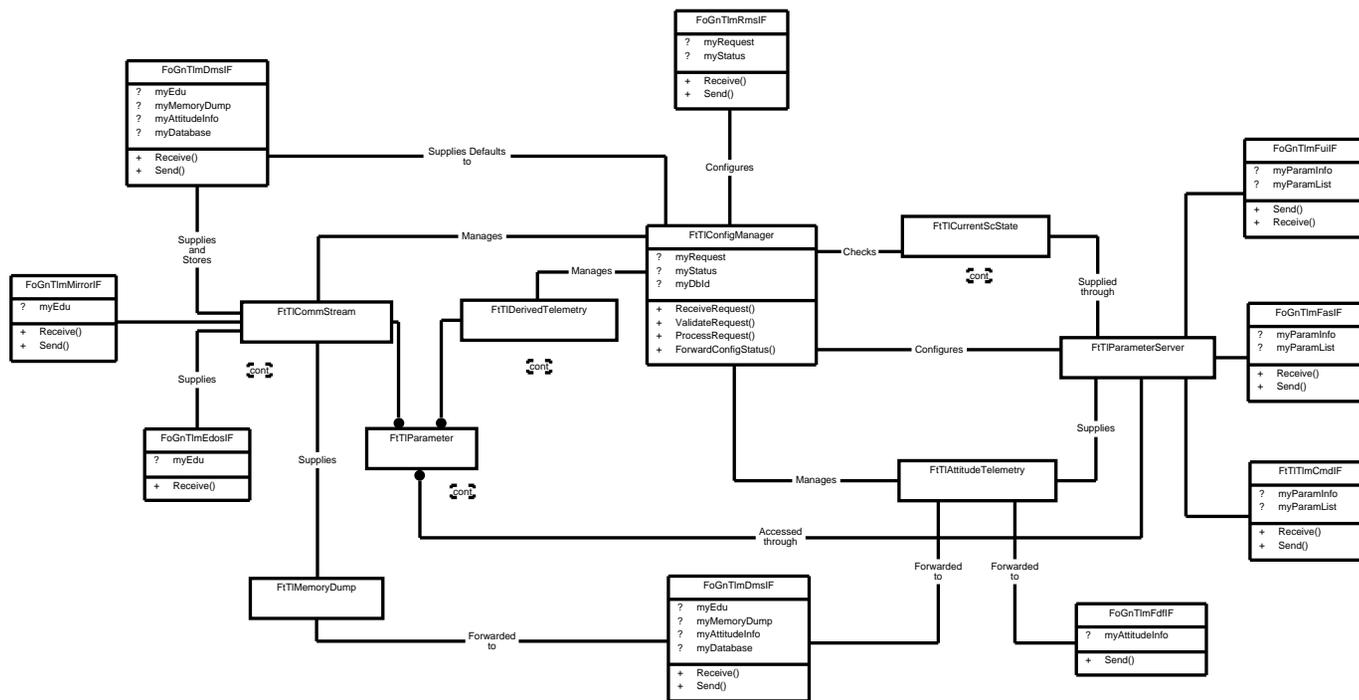
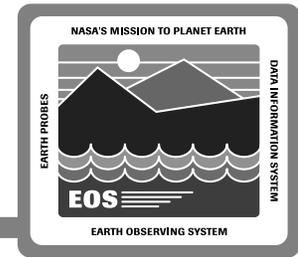
- **Build derived parameters**

Process parameters

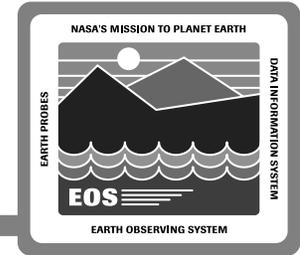
- **EU convert**
- **Limit check**

Distribute processed parameters

Telemetry Decom Object Model



Data Reduction



Sample Rate

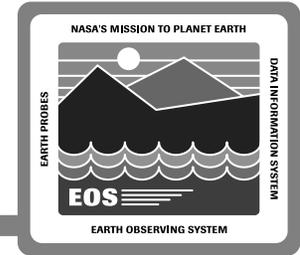
- All data
- Changes only
- Every nth sample

Data Filter

- All data
- Min-max reduced, with a specified time interval



Algorithms

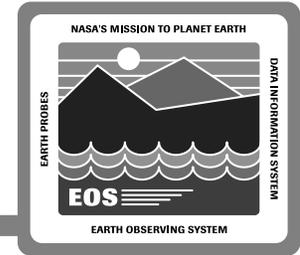


An algorithm is the last step during processing

To create and use an algorithm, 3 steps are required:

- **Writing the Algorithm**
- **Registering the Algorithm**
- **Using the Algorithm**

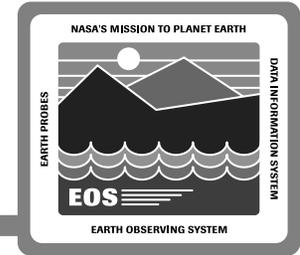
Writing the Algorithm



The function is compiled into an object file



Registering the Algorithm

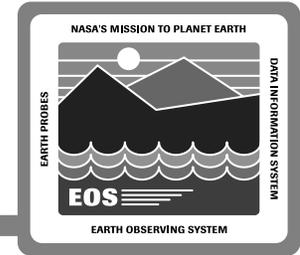


Using the Algorithm Tool, the user specifies the following:

- **Algorithm Name**
- **Object File**
- **Mnemonic Name**
- **The number of discrete and analog values used in the algorithm**
- **The user specifies legal parameters for each discrete and analog value**

After registering the algorithm, the algorithm is available from the Request Builder

Using the Algorithm



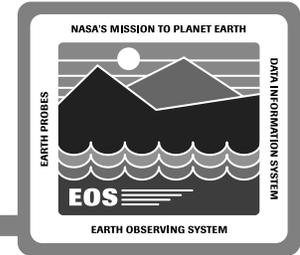
Using the Request Builder, the user specifies the desired algorithm

For each of the algorithm's arguments, the user selects one of the legal parameters (which were specified when registering the algorithm)

The selected parameters are added to the list of parameters required for the request

The mnemonic name of the algorithm is also added to the list of required parameters

Using the Algorithm (cont.)



Prior to processing the request, the algorithm's object file is dynamically linked into the analysis program

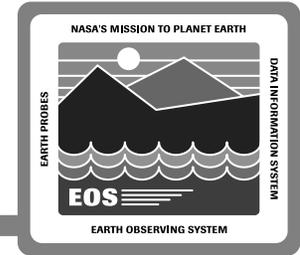
The algorithm can then be called as if it were built in to the system

During processing, after the sample rate and data filter have been applied, the parameters selected for the algorithm are collected and sent to the algorithm

The algorithm is then called to compute the result

The result is placed into the output dataset or report

Algorithm Benefits



Algorithms are easily defined

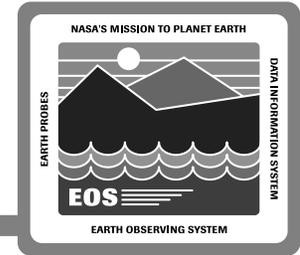
Multiple algorithms may be used in the same request

Algorithms are integrated into the Analysis system

Algorithms are compiled and therefore run much faster than an interpreted STOL procedure

Allows the FOT/IOT to define an algorithm which will supply data for their specific needs

Report Preparation



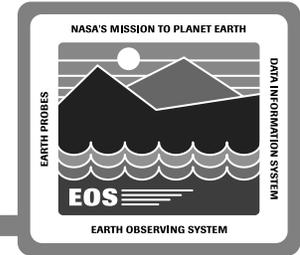
Reports may be routine or custom

To Analysis, custom reports appear as simple dataset requests

Routine reports are pre-defined in the system

- **Examples:**
 - **Downlink Ordered Report**
 - **Power Performance Report**
 - **Propulsion Performance Report**

Report Preparation (cont.)

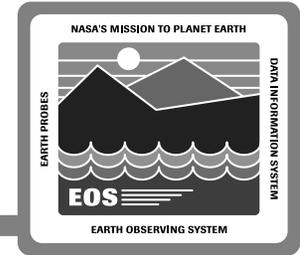


Routine reports can be made into standing orders

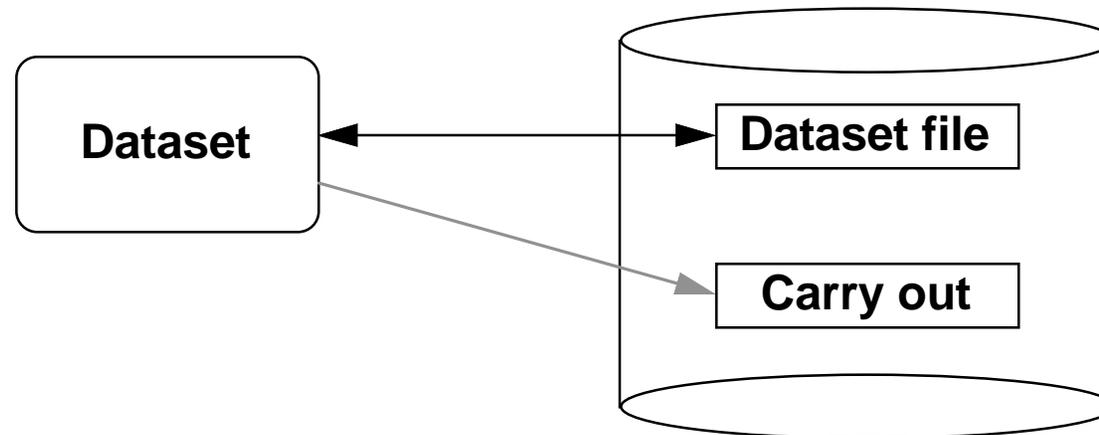
Routine reports may contain analysis requests -- some, such as a Memory Image Compare Report, will not require an analysis request

Upon completion of processing, the report is displayed, printed, or archived per the user request

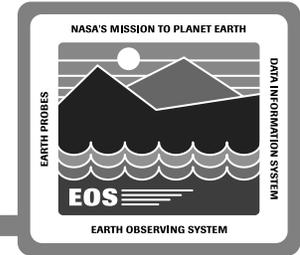
Dataset



A dataset is an object which manages a file



Dataset (cont.)

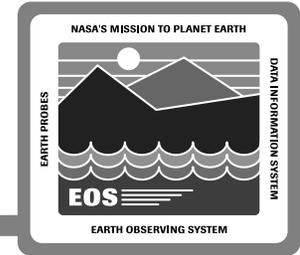


As each parameter value is processed, it is written to the dataset
A dataset will contain the following information for each telemetry point:

- **Time**
- **Raw value**
- **EU converted value (if requested)**
- **Quality status indicator**
- **Out-of-limits low indicator**
- **Out-of-limits high indicator**
- **Delta limit error indicator**
- **Conversion error indicator**
- **Invalid parameter indicator (indicates if the parameter is valid for the data base being used)**

After the dataset has been created, it is used to generate an output product

Dataset Benefits

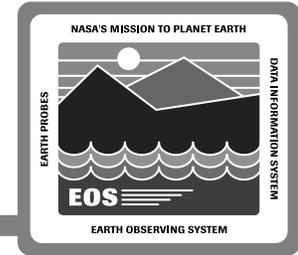


Datasets are a standardized output

- **Can be used to generate any analysis output product**

Datasets are not limited in size

Analysis Phase



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Setup

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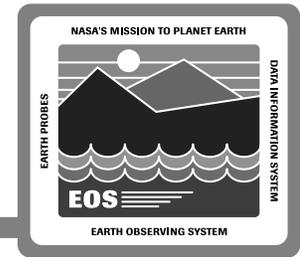
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- **Output Generation**
- **Graphs**
- **Tables**
- **Reports**
- **Carry Out**
- **Dataset Overlays**

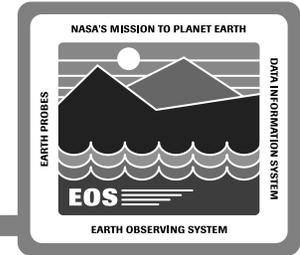
Output



Analysis datasets can be viewed/output in several ways

- **Graphs**
- **Tables**
- **Reports**
- **Carry Out**
- **Dataset Overlays**

Output Generation



The analysis data handler creates the output products, that were specified in the original request, from the generated datasets

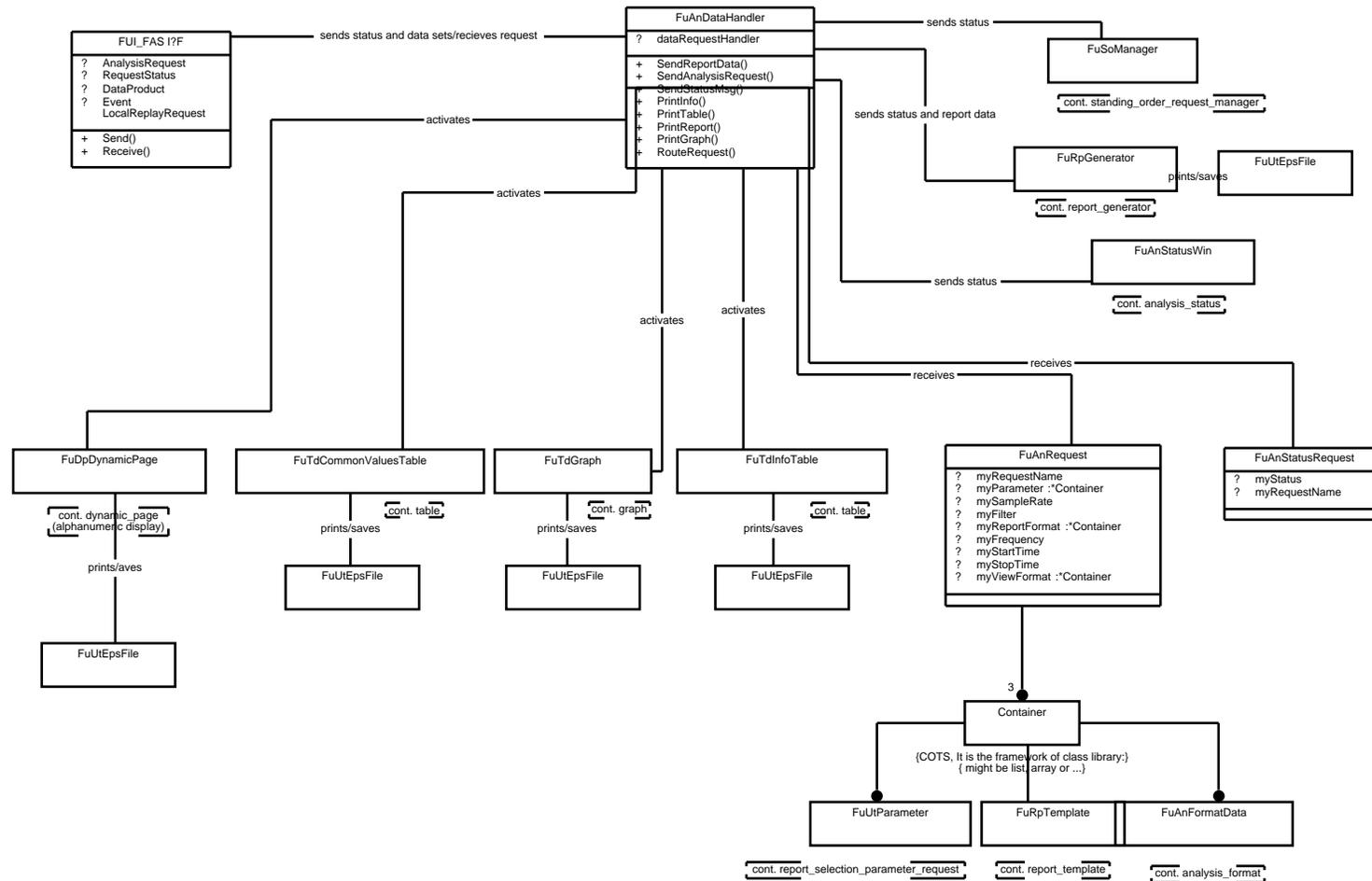
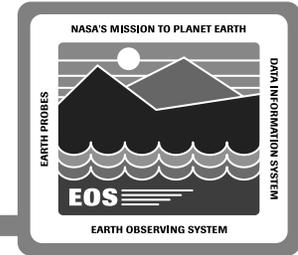
- **Graph**
- **Table**
- **Report**
- **Carry out data**

Status of a request can be viewed using the analysis status window

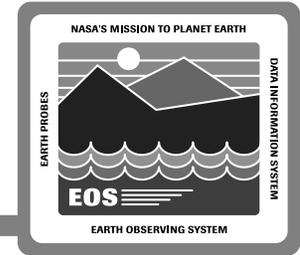
Once the original request has been satisfied, the user may generate other analysis products using the product selector window

- **Generate other graphs, tables, reports, carry out data using the original datasets**

Output Generation Object Model



Graphs



Graphs can present analysis data in two ways

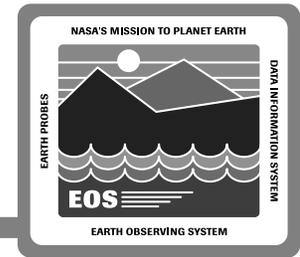
- **Parameters vs time**
- **Parameters vs parameter**

The users will be able to specify/modify the characteristics of a graph

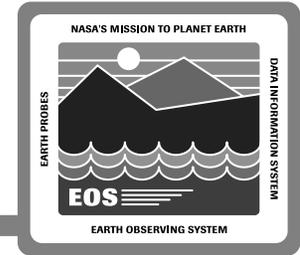
Graphs can be output to a file or printer as encapsulated postscript

A graph is displayed/output using the same mechanisms as a real-time graph (graph display item in a dynamic page)

Prototype Graph Display



Tables



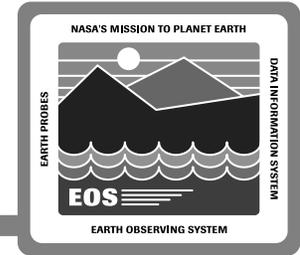
A table is a spreadsheet-like presentation of the analysis data

- **Contains all parameter values requested**
- **Contains all times at the interval requested**

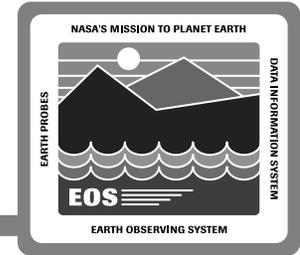
A table can be output to a file or printer as encapsulated postscript

A table is displayed/output using the same mechanisms as a real-time table (table display item in a dynamic page)

Prototype Table Display



Reports



Reports have two forms, routine and custom

- **Routine Reports**

- **User only specifies type of report and input data, and receives pre-formatted report**

Start time, stop time, parameters, etc.

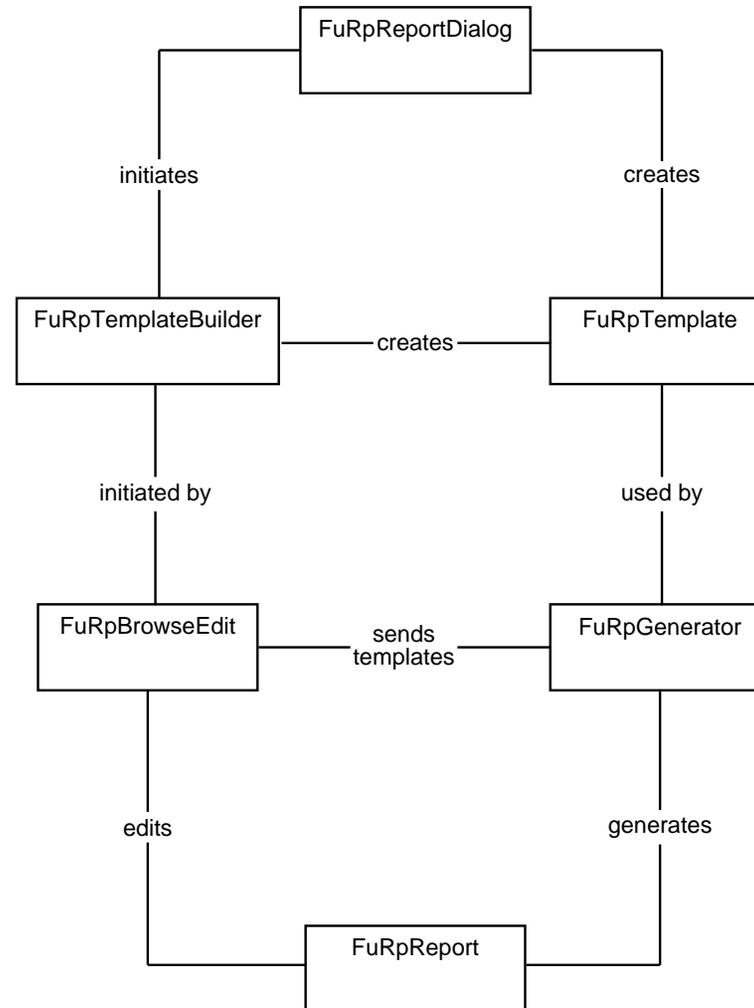
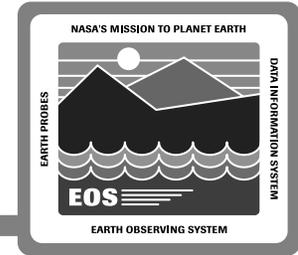
Memory image compare, propulsion performance, down-link ordered list, instrument performance, etc.

- **Custom Reports**

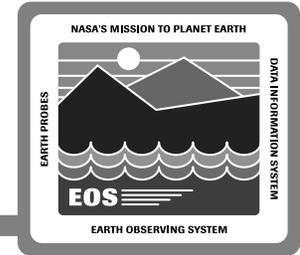
- **User specifies text and data contents/format of the report**
- **Can contain text, graphs, tables and page snaps**

Datasets are used to generate the graphs and tables that are inserted into the report

Report Object Model



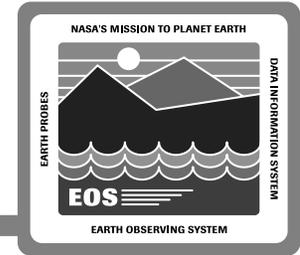
Report Scenario



An example of a standing order which produces a custom report:

- **User defines analysis products using the analysis request builder**
 - **2 graphs**
 - **1 table**
- **User defines report format and adds descriptive text using report template builder**
- **User registers this custom report template as a standing order**
 - **Generate report the second week of every month**
- **The standing order manager automatically generates the report**
 - **Makes analysis request for dataset**
 - **Uses dataset to generate 2 graphs and 1 table**
 - **Passes graphs and table to report generator**
 - **Report generator uses template to create report**
 - **Report is sent to the printer**

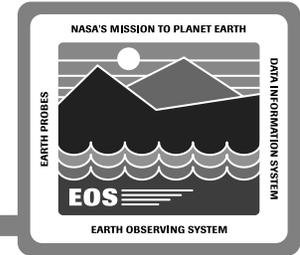
Carry Out Data



Any analysis dataset can be generated as a carry out data file

- **ASCII file**
- **Human readable**
- **Can be imported into COTS applications (LOTUS 123, MS-EXCEL, SAS, Mathematica, PV Wave, etc.)**
- **Can be exported to another computer or copied onto magnetic media**

Dataset Overlays

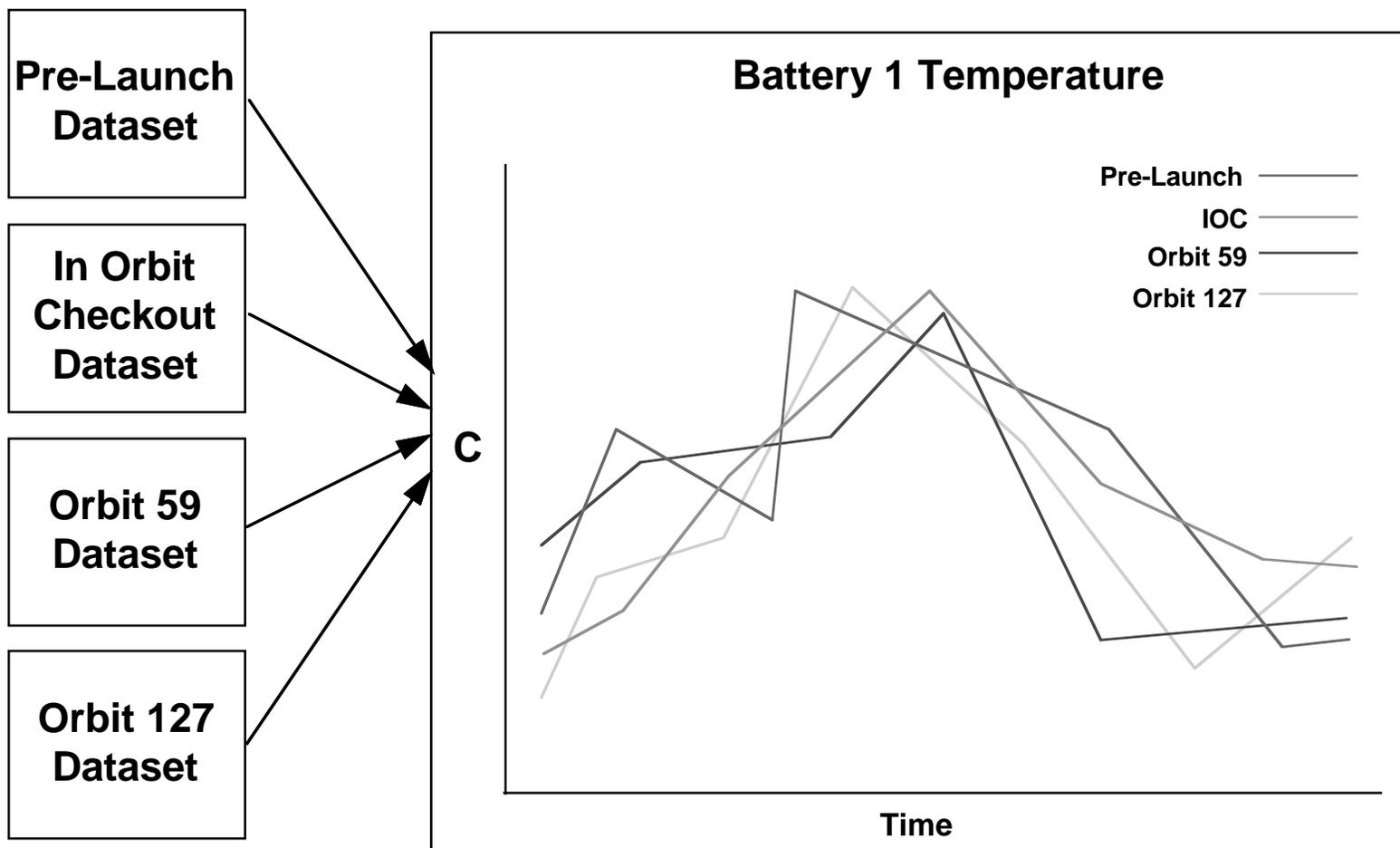
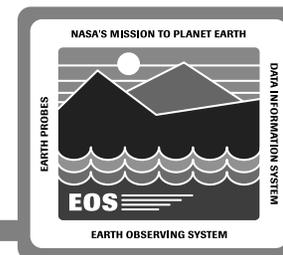


A dataset overlay is a combination of discontinuous sets of data that need to be viewed together

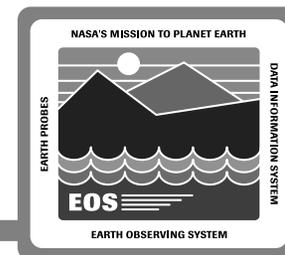
- **Solar array currents from different orbits on the same graph**
- **Battery depth-of-discharge from different orbits on the same table**
- **Signal strength data from different seasons in the same report**
- **Baseline pre-launch data vs flight data**
- **In orbit checkout data vs current data**
- **etc.**

Data from multiple datasets can be combined to produce a single graph, table, report or carry out file

Dataset Overlays (cont.)



Analysis Output Design Benefits



- Request different views of analysis data
- New views can be created using existing datasets
- Data from different time periods can be viewed in one output product (dataset overlays)
- Custom reports can contain graphs, tables, screen snaps and text
- Reports and analysis requests can be performed as standing orders
 - Reduces analyst workload
 - Provides consistent, timely data
- Data can be carried out for use in external packages
- Analysis graphs and tables are displayed using the same mechanisms as in real-time displays
 - User only learns one interface
 - Software reuse

Graph Object Model

